# Habitat restoration and suspended sediment

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Please ask questions

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# Importance of sediment

- Sediment deposition builds the Delta landscape
- Suspended sediment provides or limits habitat for specific species

DEPARTMENT OF BOATING AND WATERWAYS

**PUBLIC NOTICE**

***Egeria Densa* Control Program**

The California Department of Boating and Waterways (DBW) is conducting an herbicide program to control *Egeria Densa* in certain areas of the Sacramento-San Joaquin Delta Region.

The following information is subject to change based on governmental requirements, weather conditions, plant growth, waterway traffic, and other conditions.

**Treatment Period**

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# Outline

- Suspended-sediment trends
- CASCaDE: sedimentation scenarios
- Cache Slough: lessons learned from the Delta's most turbid waters
- Data collection to support model development

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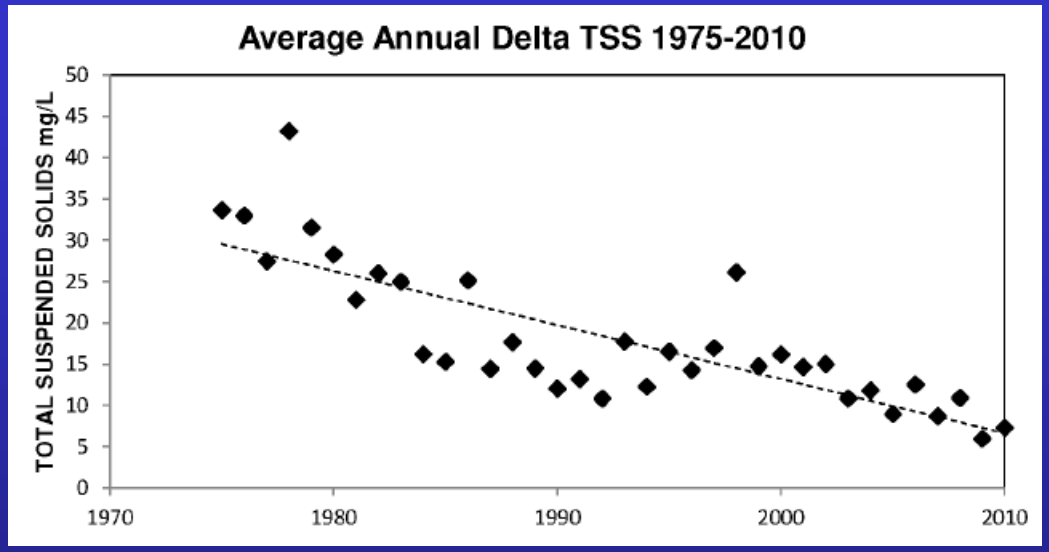
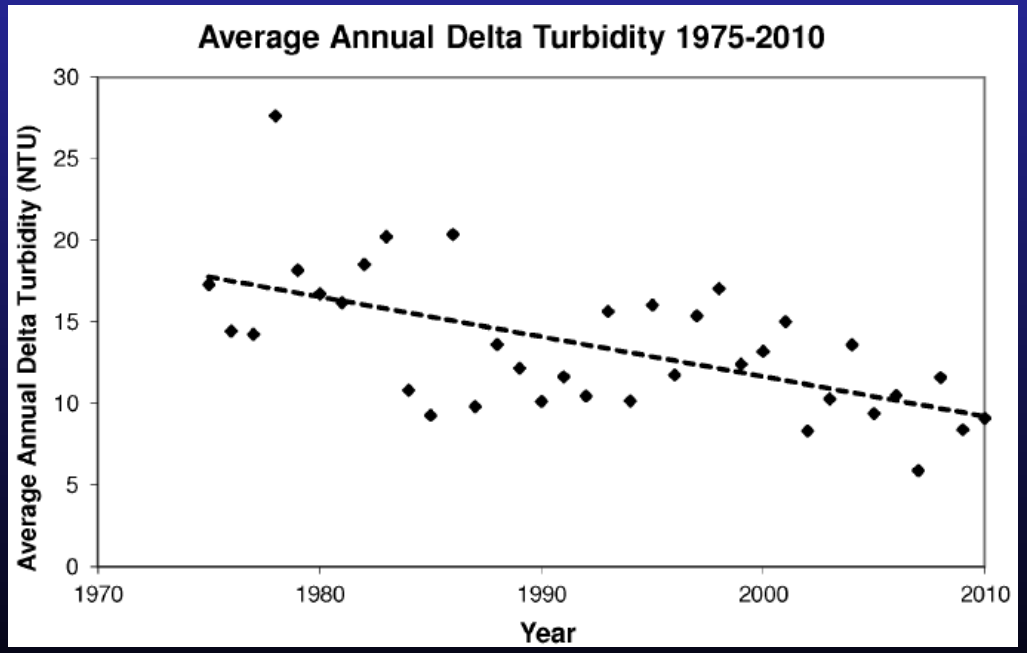
# Historical turbidity and sediment




IEP monthly sampling

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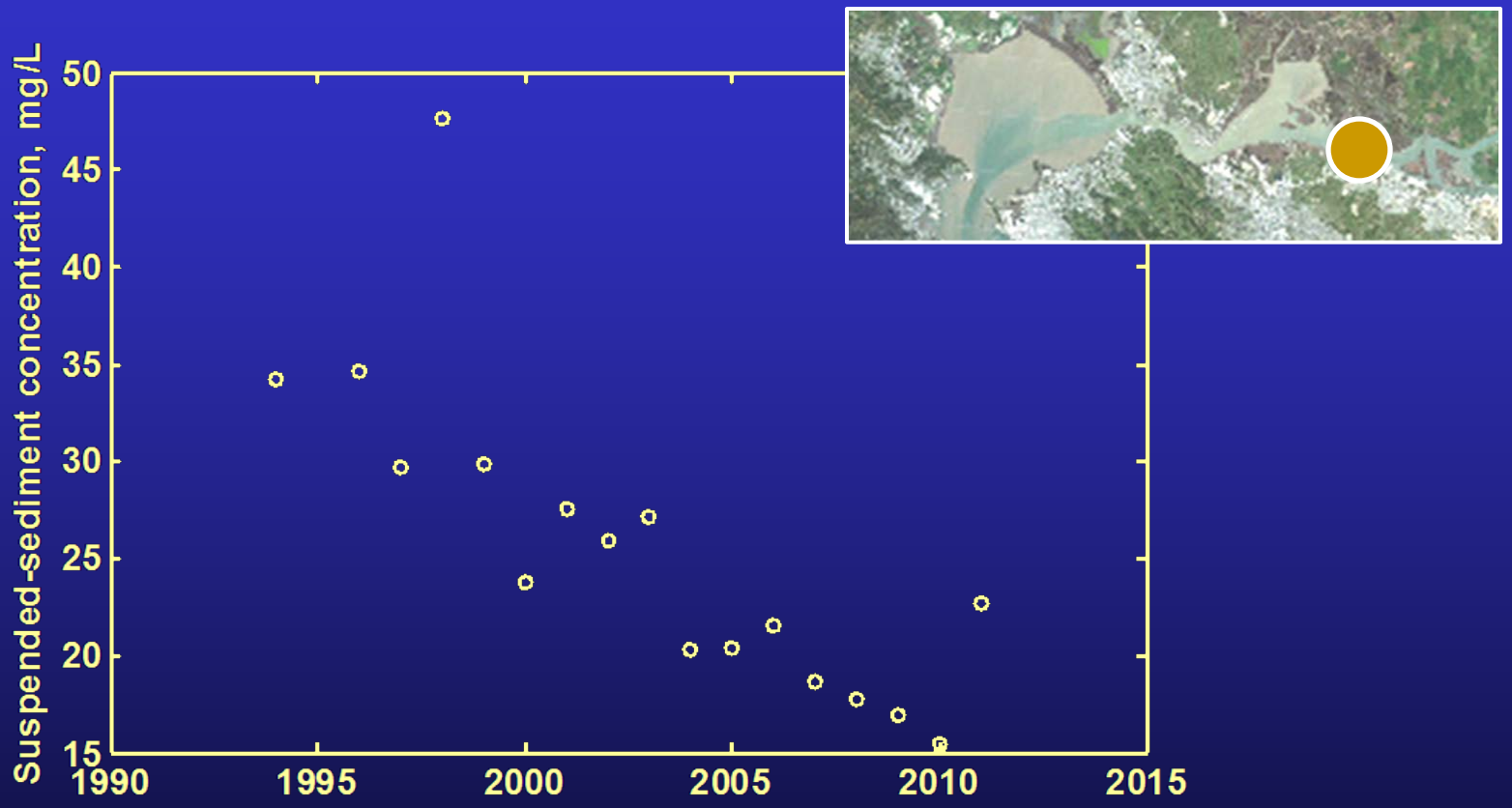
# Near-surface SSC at Mallard Island, September-October mean values, 1994-2011




SSC decreased ~50% 1994-2011

Buchanan and others 1995 - in press

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# Why less sediment?

12~13 $Mm^3$/yr less than peak (~90%)

1) Diminishment of hydraulic mining pulse: adjustment in steps with larger flows (Schoellhamer et al submitted)

2) Reservoir deposition: Deposition in Oroville, Folsom, and Englebright ~2.4 $Mm^3$/yr (Wright and Schoellhamer 2004)

3) Flood bypasses: Deposition in Colusa, Sutter, Yolo near Fremont Weir 1.3 $Mm^3$/yr (Singer and Aalto 2008)

4) Bank protection: Banks on over half the lower Sacramento River were protected from 1960-2000 (USFWS 2000)

5) New sediment traps: Invasive submerged aquatic vegetation in Delta (Schoellhamer et al submitted)

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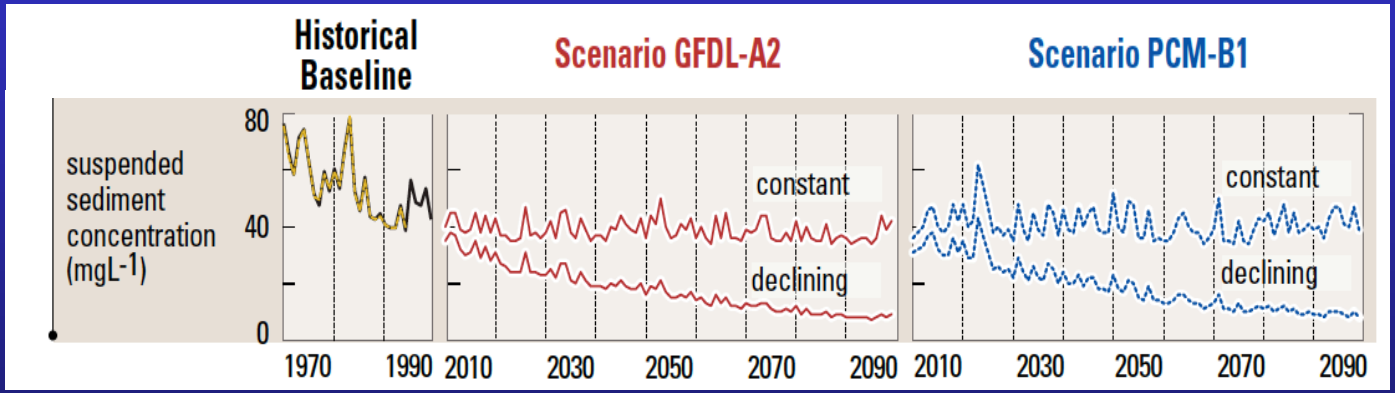
# Will decreasing trend continue?




- 25 mg/L
- 26 mg/L

CASCaDE: Cloern et al 2011

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# Example 30-year scenarios

Sea-level rise:

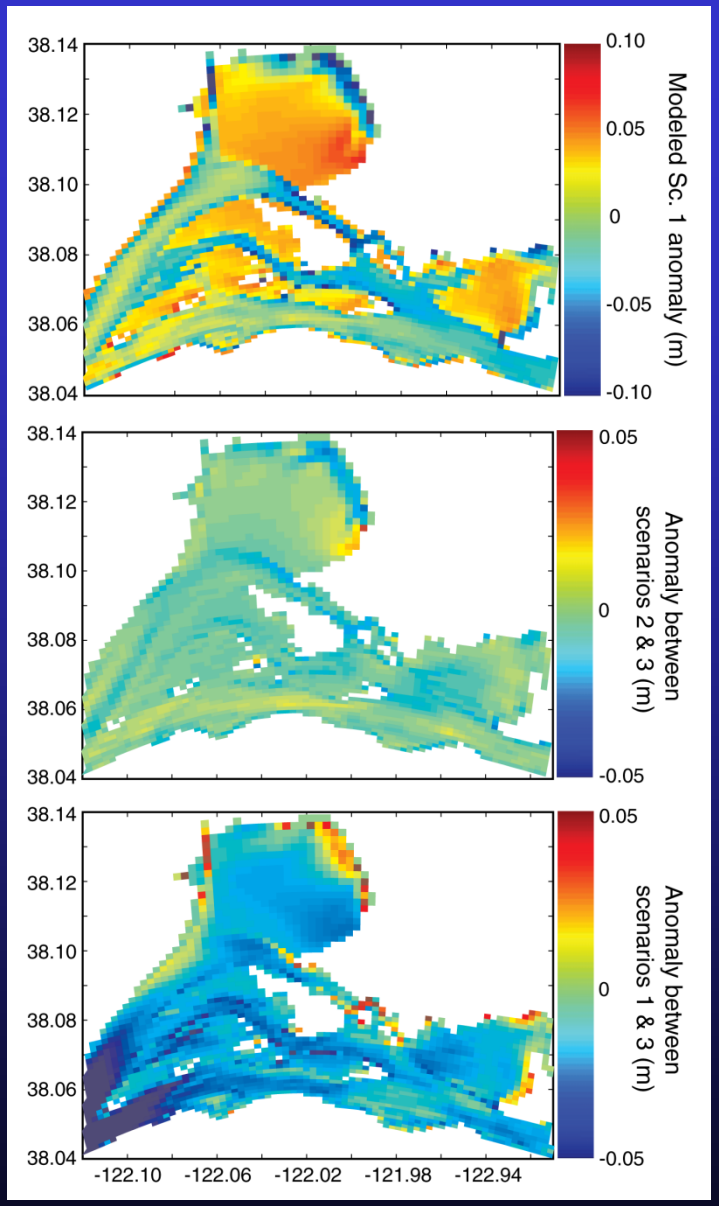
- Increase in water depth reduces wave-induced shear stress
- Less erosion, less redistribution

Warming:

- Minor changes in redistribution

Decreased sediment supply:

- Erosion everywhere except fringes




CASCaDE: Ganju and Schoellhamer 2010

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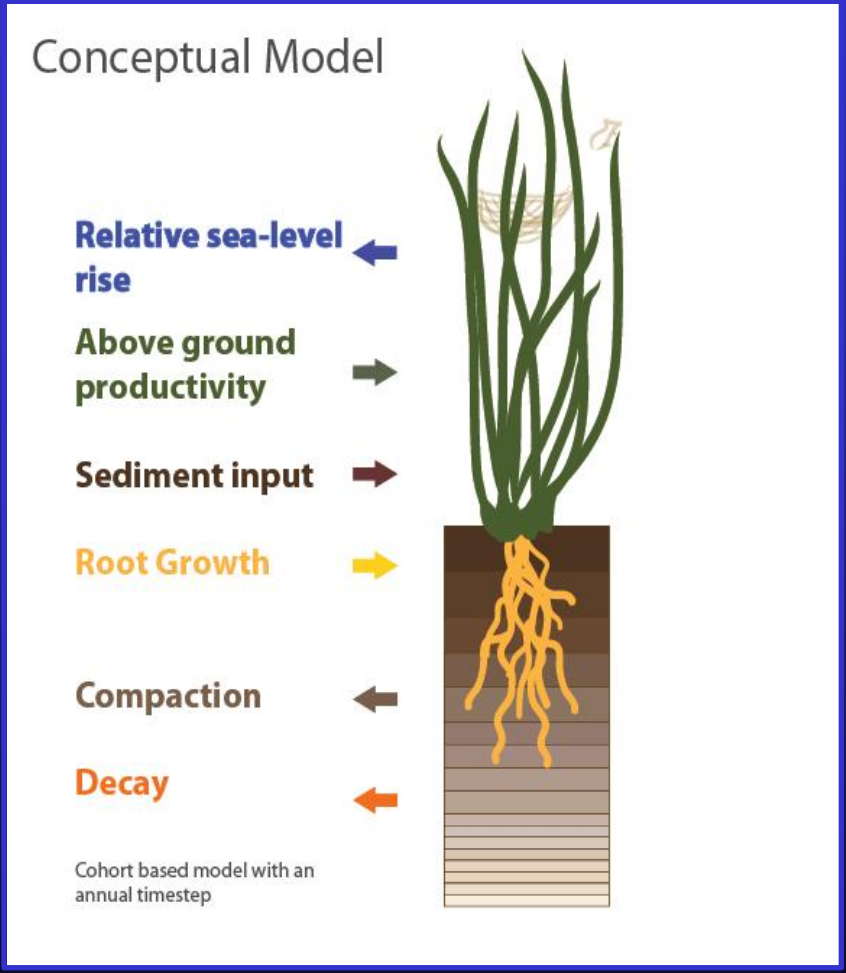
# Wetland Accretion Model of Ecosystem Resilience (WARMER)




- Data from 4 Delta marshes
- Simulate all combinations (450) of porosity (2), initial elevation (3), organic matter accumulation (3), inorganic sediment accumulation (5), sea level rise (5).
- Sediment scenarios: minimum, median, and maximum historic and modern sediment supply. Median and maximum scenarios with decreasing supply (-1.6%/year)

From Swanson et al., submitted to Estuaries and Coasts



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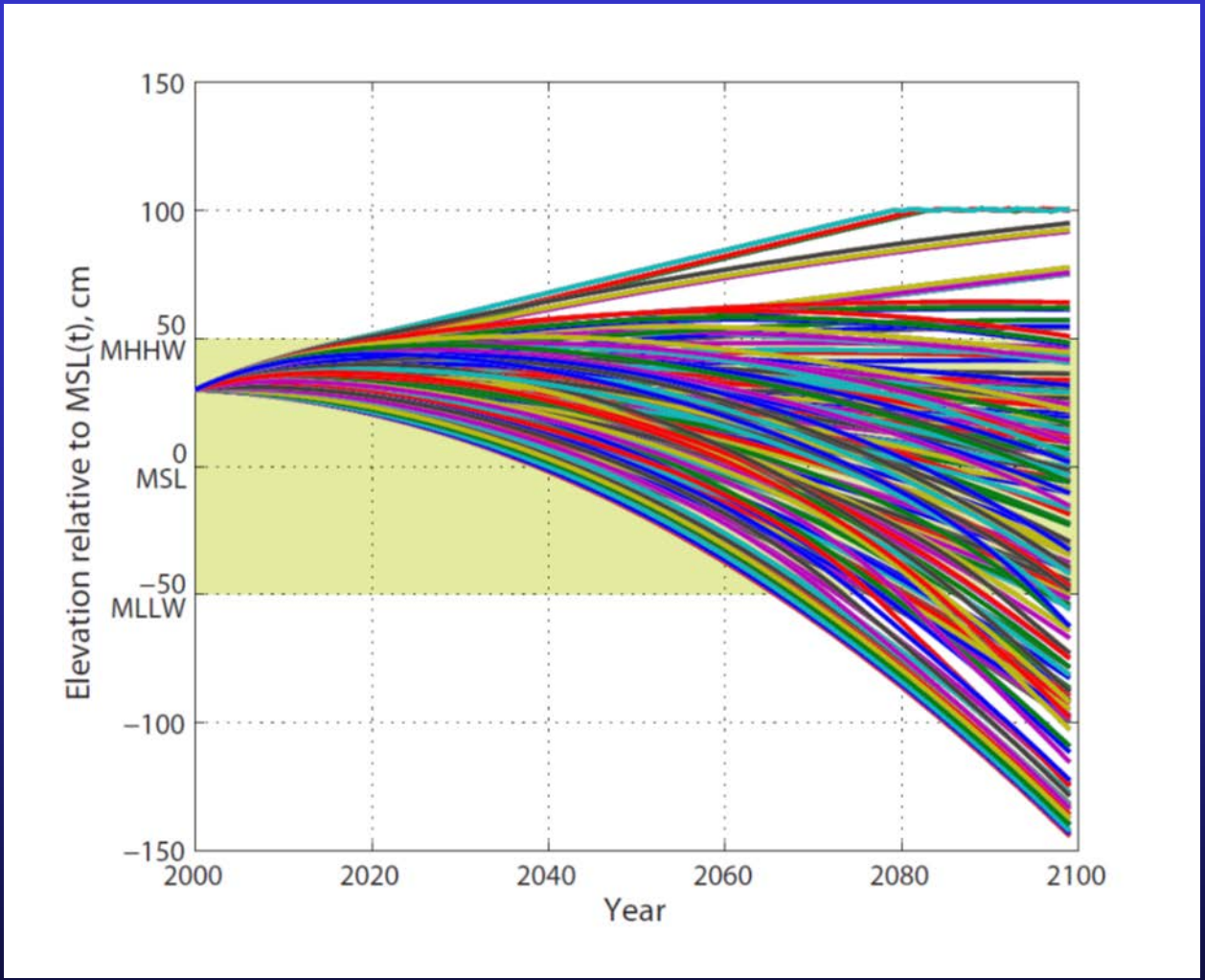
# 150 scenarios with 30 cm initial elevation




55% of scenarios finish within elevation range of marsh vegetation

From Swanson et al., submitted to Estuaries and Coasts

CASCaDE II: Swanson et al submitted

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# Results most sensitive to sea level rise and sediment supply

| 2100 sea level rise (cm) | Scenarios with marsh in 2100 |
|---|---|
| 88 | 84% |
| 133 | 32% |
| 179 | 11% |

| Inorganic sediment accumulation ($g/cm^2/yr$) | Scenarios with marsh in 2100 |
|---|---|
| 0.003 | 52% |
| 0.038 – 1.6%/yr | 54% |
| 0.038 | 59% |
| 0.23 – 1.6%/yr | 70% |
| 0.23 | 90% |

From Swanson et al., submitted to Estuaries and Coasts

CASCaDE II: Swanson et al submitted

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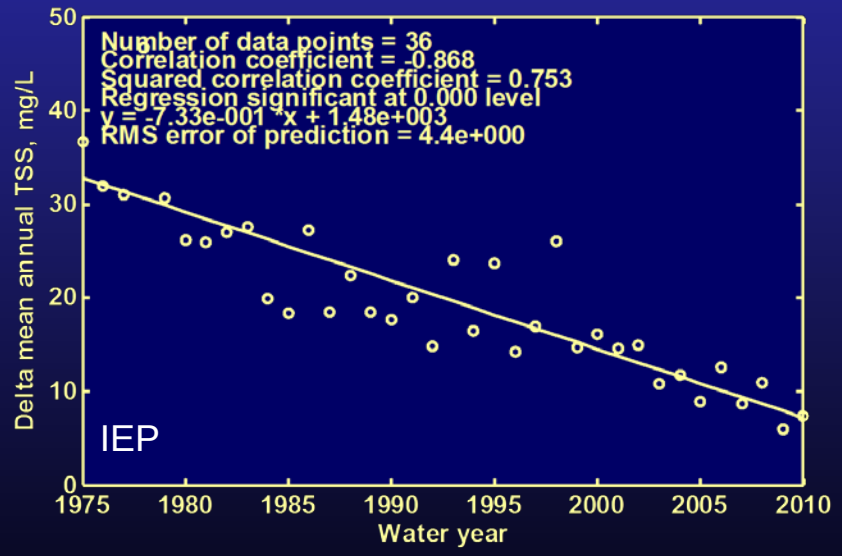
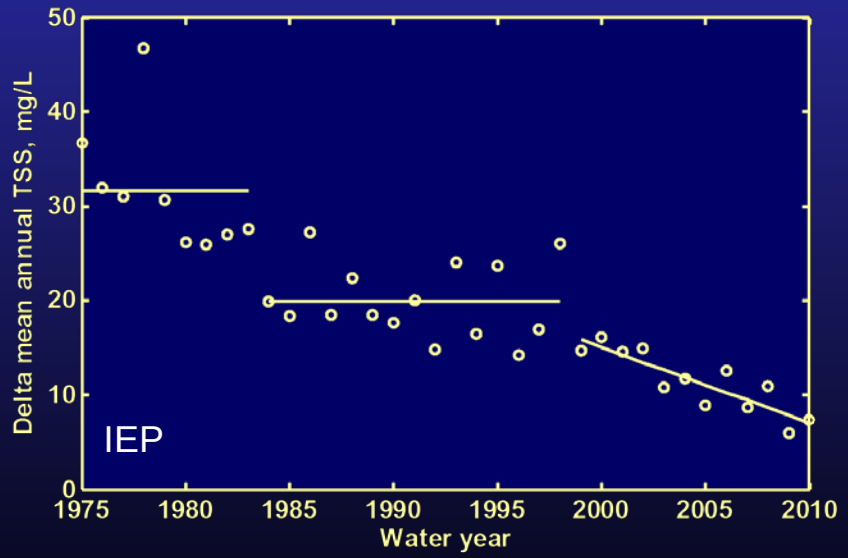
# Will decreasing trend continue?
# What we know:

Sediment supply is decreasing

The watershed and estuary are adjusting to decreased supply

Recent step changes in bed elevation and suspended sediment are associated with the largest floods since hydraulic mining




Schoellhamer et al submitted

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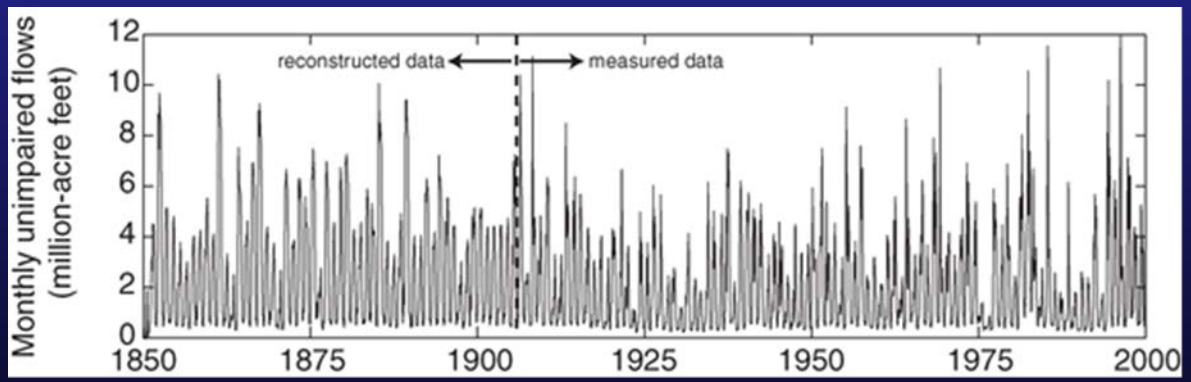
# Hypothesis

It is likely that the estuary and watershed are still capable of adjusting but further adjustment will be as steps that occur only during greater floods than previously experienced during the adjustment period.

Larger and larger floods are needed to exceed geomorphic thresholds and cause adjustment. Between large floods are periods of equilibrium.




Ganju et al 2008

Schoellhamer et al submitted

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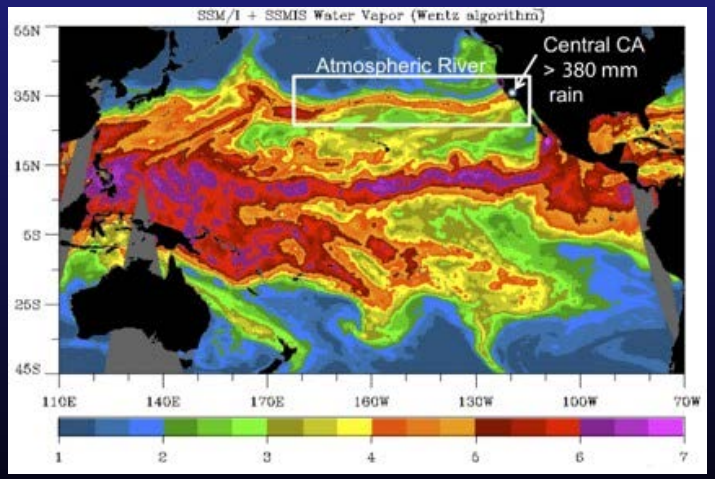
# Flood control

Humans are trying to prevent larger floods

Success:  No more adjustment, watershed and Bay are in a stable adjusted regime.

Failure: Catastrophic flooding, further adjustment

A flood with a 500 year or greater return period likely would overwhelm the Sacramento Valley flood control system (Porter et al. 2011)




Schoellhamer et al submitted

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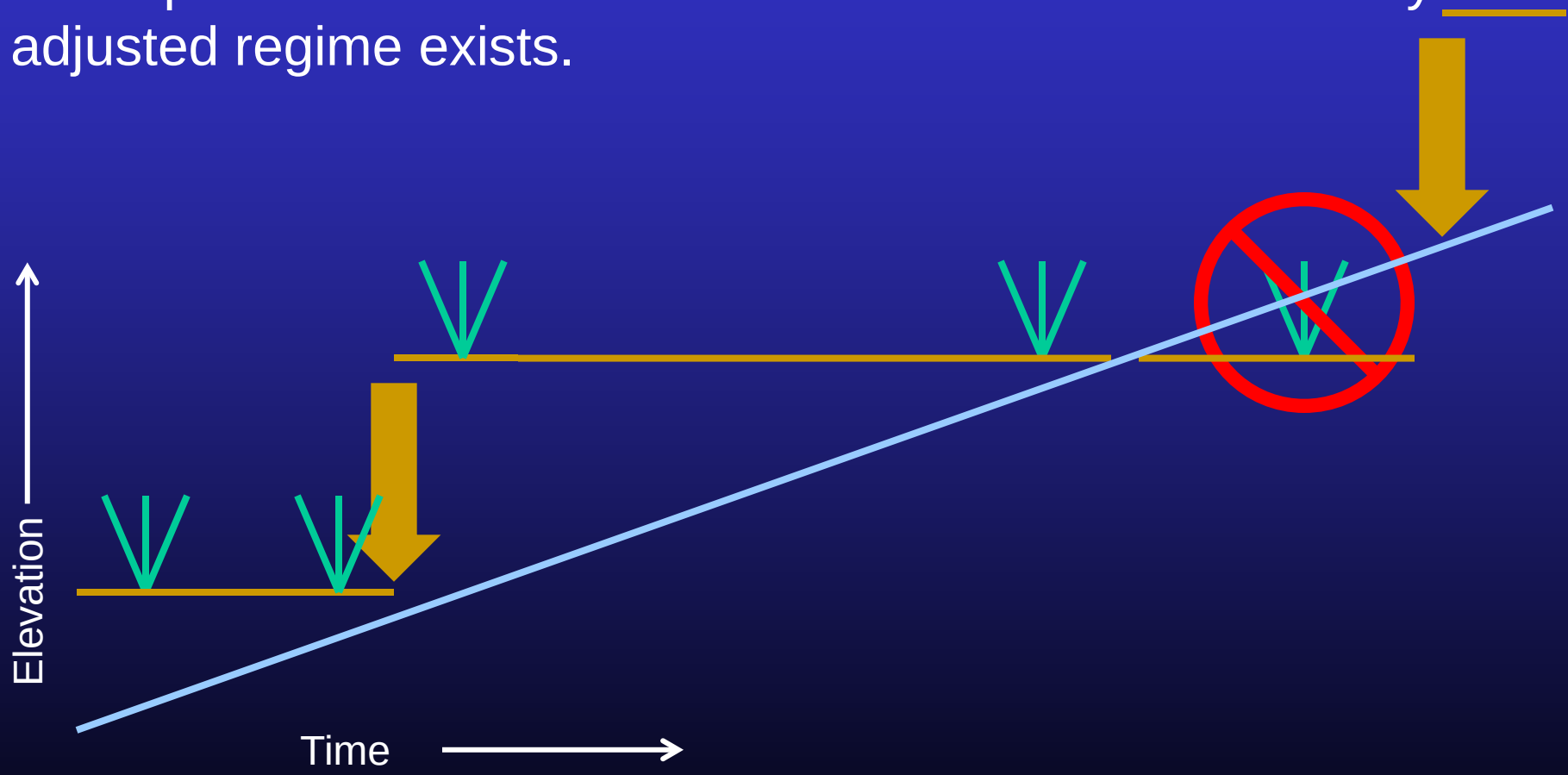
# Tidal marsh sustainability

When the return interval of adjustment floods becomes greater than ecological response times, ecological variables will adjust to the prevalent environmental conditions as if a stationary adjusted regime exists.




Schoellhamer et al submitted

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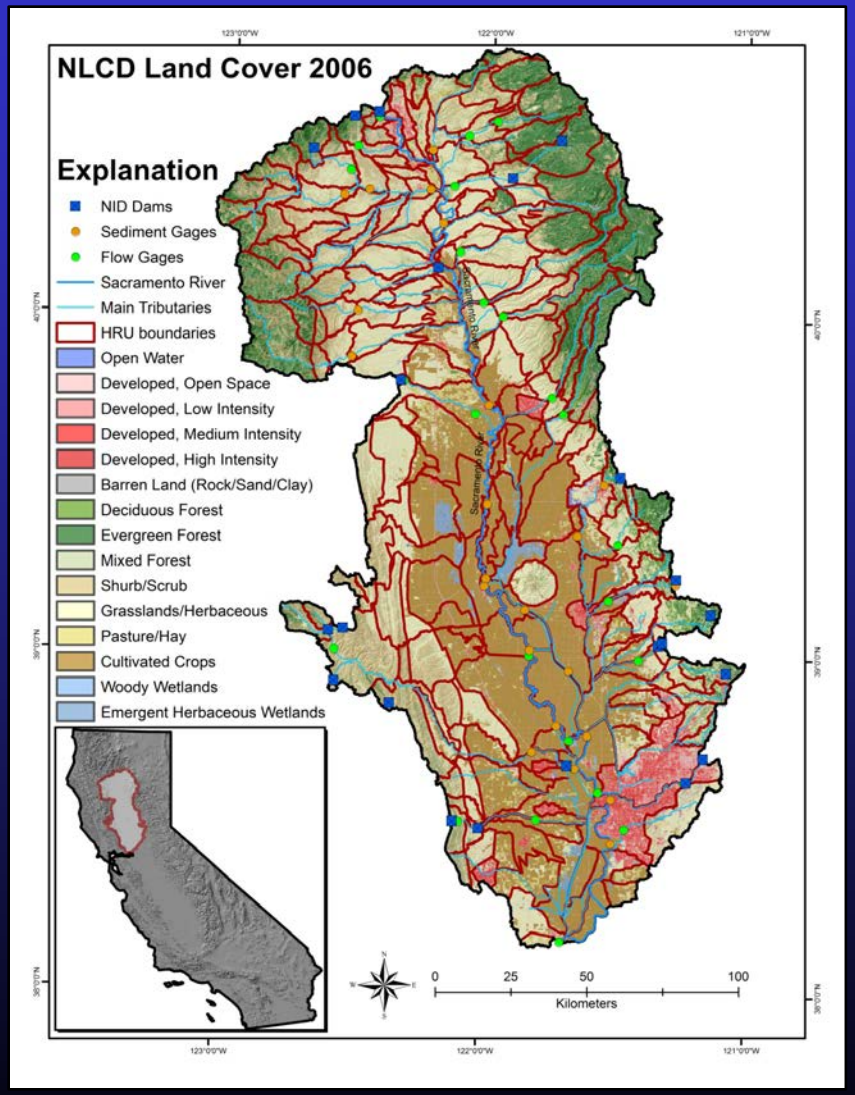
# Will decreasing trend continue? Simulating future sediment yield

CASCaDE II: Scott Wright and Lorrie Flint




HSPF model for the watershed to simulate water and sediment runoff

Linked with other models to evaluate a range of climate change scenarios for the Bay-Delta ecosystem

Much needed compilation of reservoir surveys and other historical data

## Reservoir survey compilation

| | Brown and Thorp 1947 study | PSE II dataset | Total[1] |
|---|---|---|---|
| Number of Reservoir Sedimentation Surveys[2] | | | |
| *Sacramento River basin* | *7* | *64* | *71* |
| *East-side tributaries* | *5* | *2* | *7* |
| *San Joaquin River basin* | *11* | *0* | *11* |
| Total: | 23 | 66 | 89 |
| Sediment-yield Contributing Area of Reservoirs in dataset (sq km) | | | |
| *Sacramento River basin* | *2,139* | *20,261* | *20,411* |
| *East-side tributaries* | *1,014* | *1,603* | *1,603* |
| *San Joaquin River basin* | *4,833* | *0* | *4,833* |
| Total | 7,986 | 21,864 | 26,847 |

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# Outline

- Suspended-sediment trends
- CASCaDE: sedimentation scenarios
- Cache Slough: lessons learned from the Delta's most turbid waters
- Data collection to support model development

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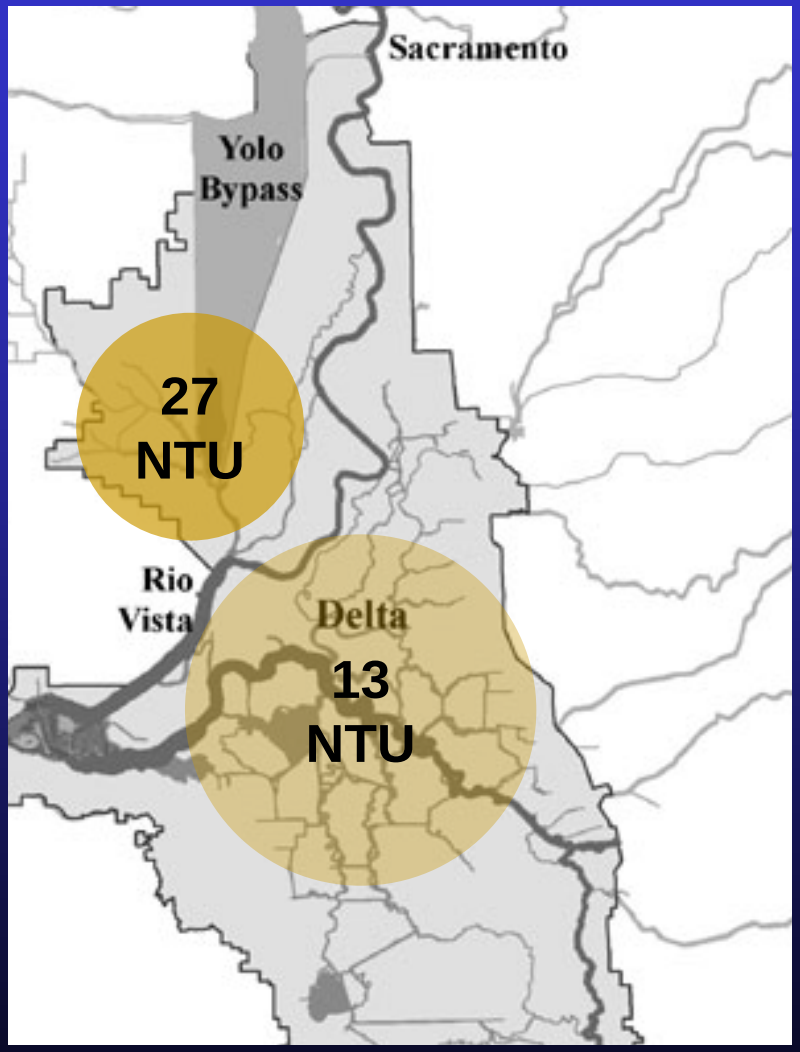
# Cache Slough: the Delta's most turbid waters
## (and favorable delta smelt habitat)




Average turbidity
WY 2009 & 2010

Morgan-King and Schoellhamer 2012, Sommer et al 2011

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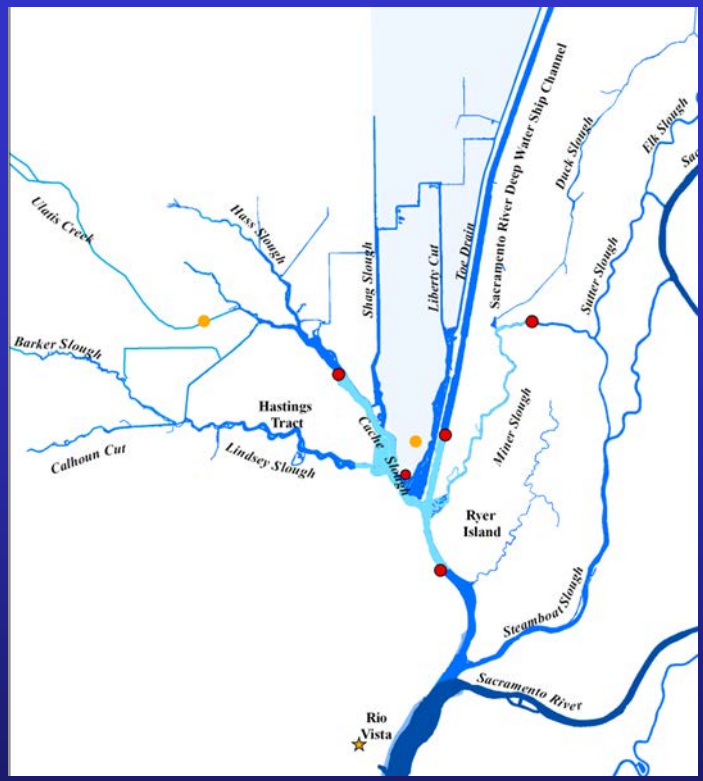
# Sediment Trapping

1) Mechanisms:
   - Dead-end channels and low freshwater flow
   - Tidal asymmetry (flood dominant velocities)
   - Limited tidal excursion

2) Trapped sediment mass undergoes a repeated cycle of tidal and wind-wave resuspension




Morgan-King and Schoellhamer 2012

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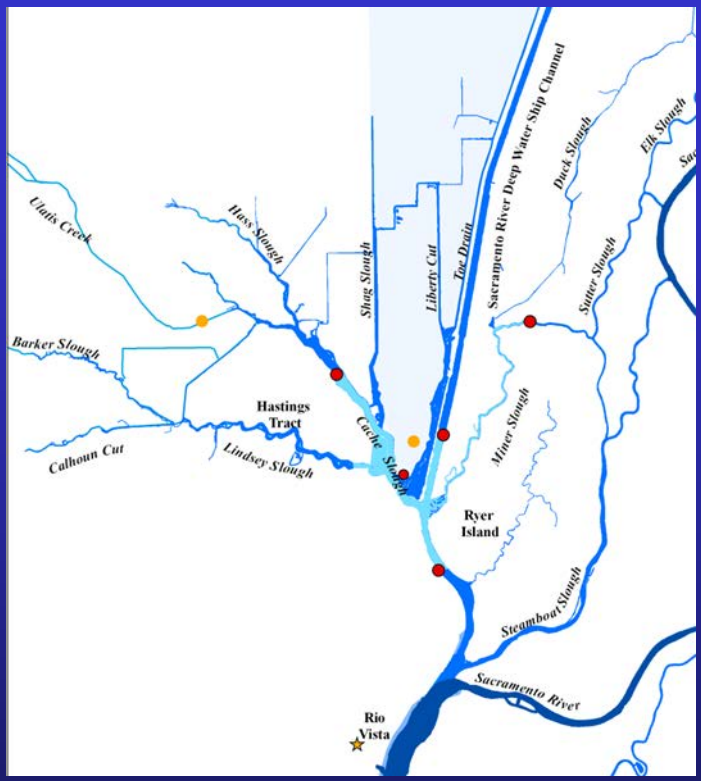
# Isolated dead-end sloughs

- Create desirable habitat
- Were once a prominent feature of the Delta
- Except for Cache Slough, the Delta is now connected waterways with little isolation




Morgan-King and Schoellhamer 2012

Early 1800s

Early 2000s

Whipple et al. 2012

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# Data collection to support numerical sediment transport models

Applying models to habitat restoration:

- Pelagic habitat and water operations
- Marsh sustainability as sea level rises
- Design restoration projects
- Dredged material disposal

Model support:

- Reliable models need reliable data
- Joint DOI/Department of Commerce Federal Task Force and US Bureau of Reclamation, 2011-2013 study

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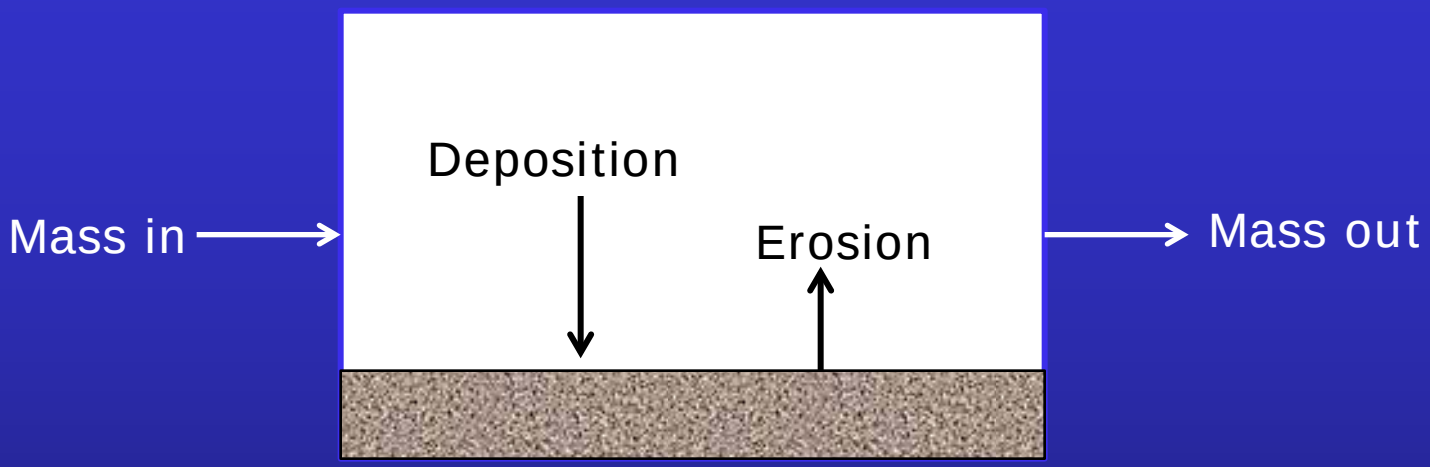
# Model requirements




Boundary conditions: Amount of sediment coming into the Delta, bottom sediment and erodibility

Model parameters: Particle size, settling velocity, erosion and deposition rates, bed roughness

Calibration data: Suspended and bed sediment information (e.g. flux) at interior Delta sites

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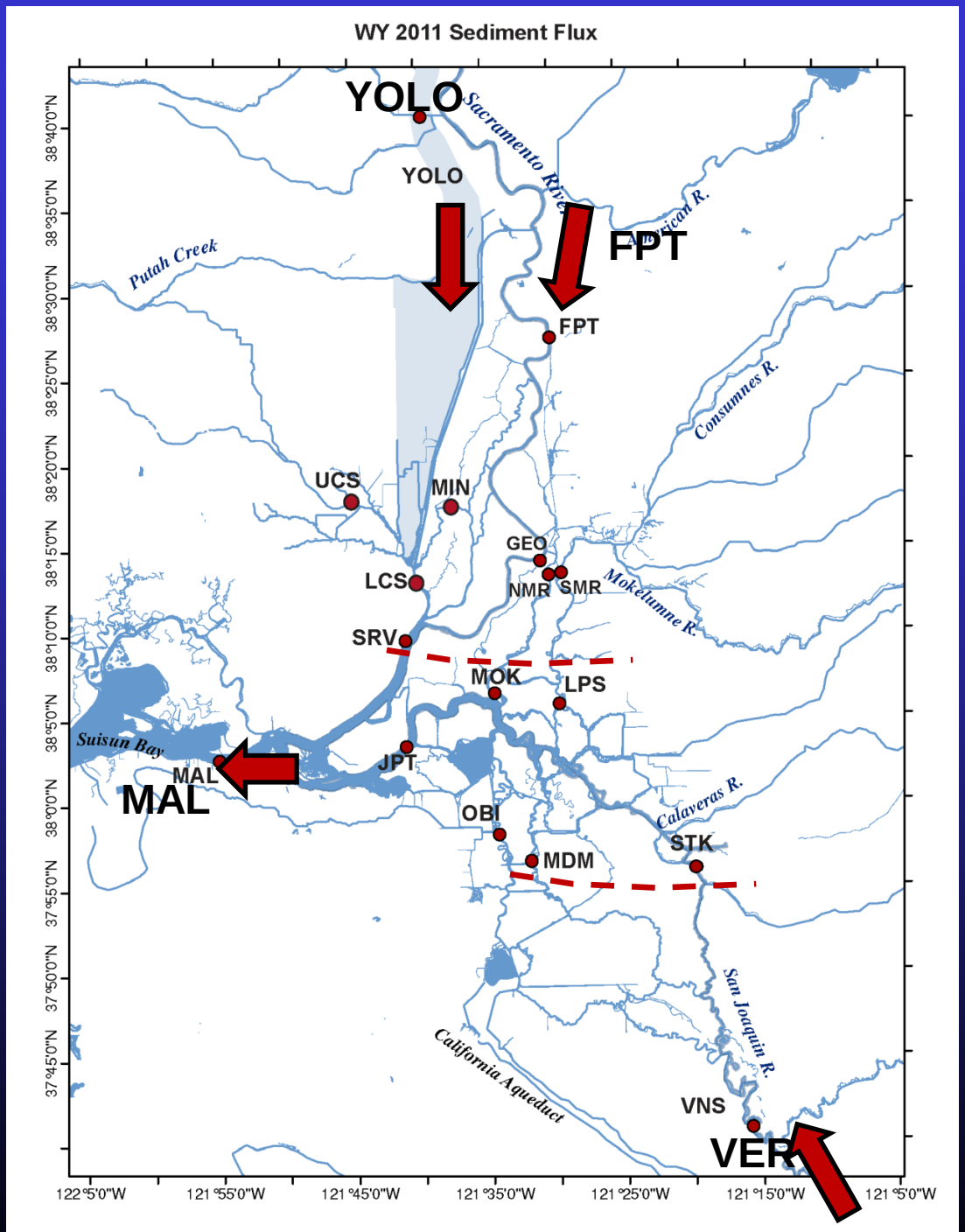


# Continuous flux measurements

**North Delta**

**In**: FPT+YOLO+SFM+NFM+UCS

**Out**: SRV+MOK+LPS

**Central Delta**

**In**: SRV+MOK+LPS+SJG+MDM+OBI

**Out**: MAL

**Southern Delta**

**In**: VNS

**Out**: SJG+OBI+MDM

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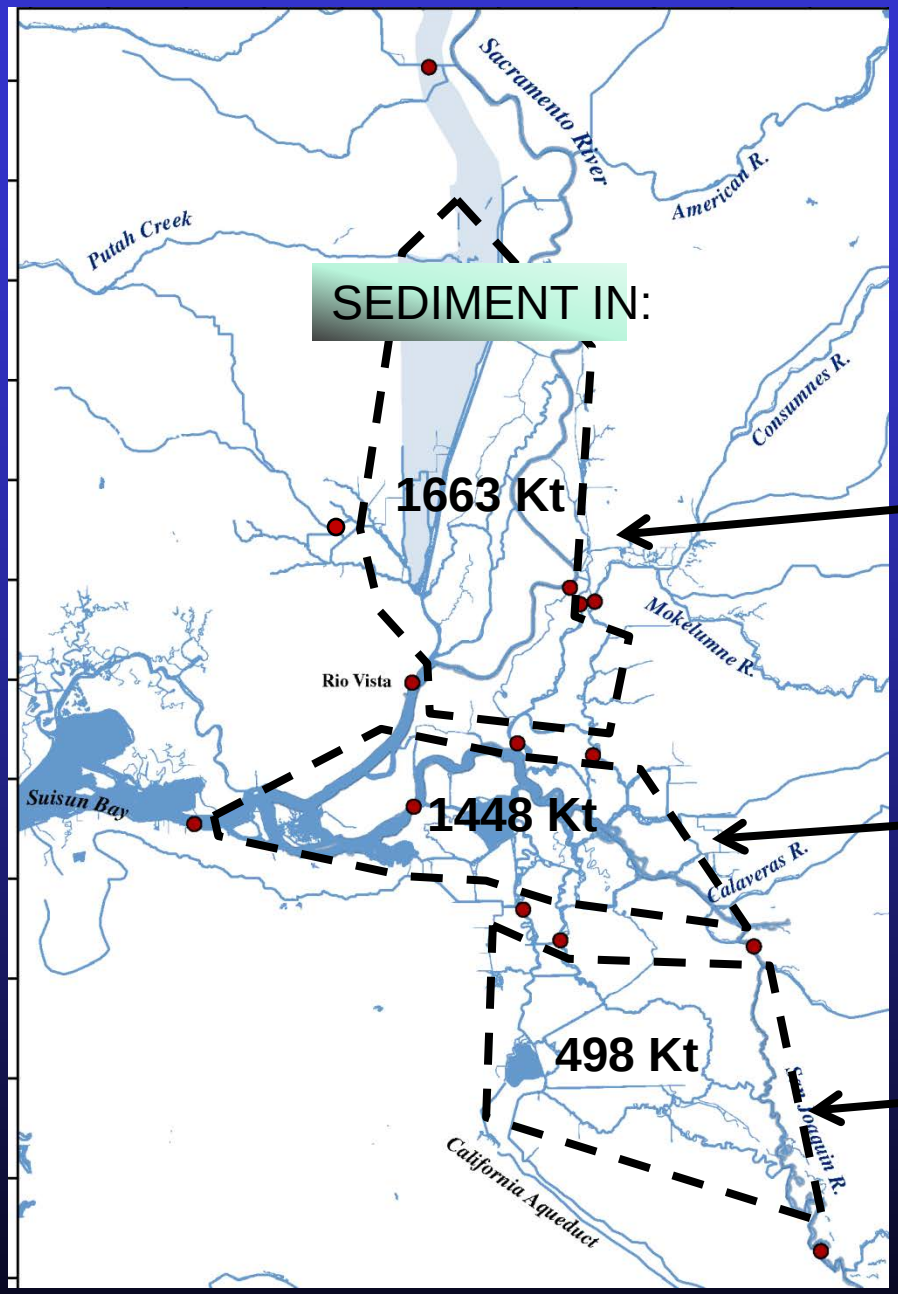


# WY2011

**Preliminary data subject to revision**

## NORTH DELTA

**Trap Efficiency: 23%**
**Deposition:380 Kt**

## CENTRAL DELTA

**Trap Efficiency: 55%**
**Deposition:796 Kt**

## SOUTH DELTA

**Trap Efficiency: 67%**
**Deposition: 332 Kt**

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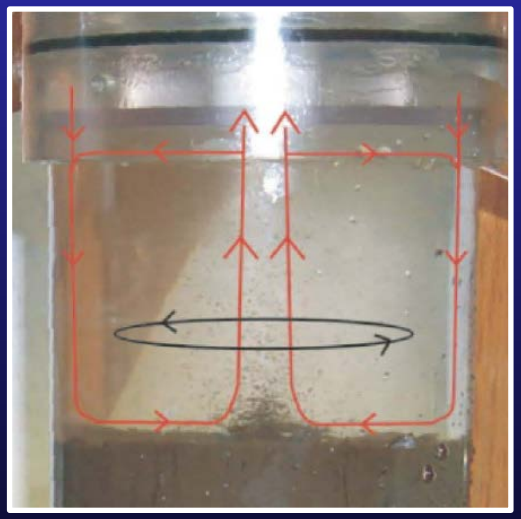
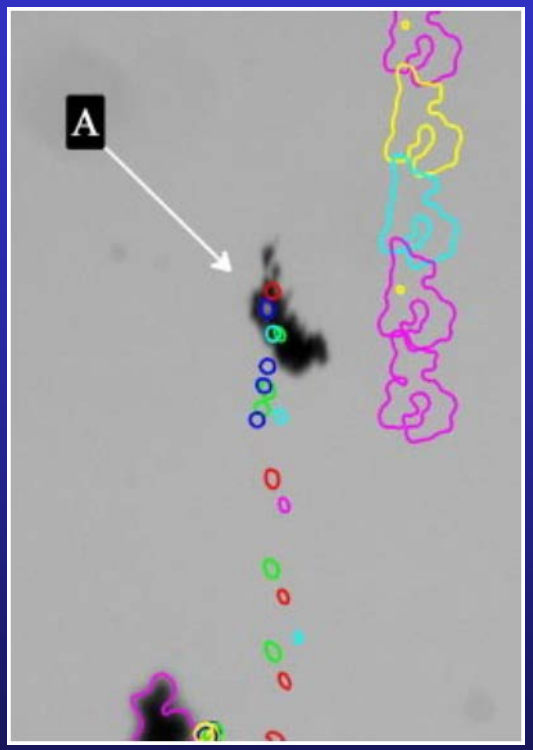
# Key model parameters

- Bed material
- Erodibility
- Settling velocity



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# Numerical modelers we have sent data to

- Delta Modeling
- Dynamic Solutions International
- PWA/ESA
- RMA
- UNESCO-IHE (CASCaDE-II)
- Presentations at BDSC and CWEMF

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# Habitat Restoration and Suspended Sediment: Summary

- Suspended-sediment trends
- CASCaDE: sedimentation scenarios
- Cache Slough: lessons learned from the Delta's most turbid waters
- Data collection to support model development

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# Acknowledgements


- US Army Corps of Engineers
- San Francisco Bay Regional Monitoring Program
- Joint DOI/Department of Commerce Federal Task Force
- US Bureau of Reclamation
- Interagency Ecological Program
- US Geological Survey Federal/State Cooperative Program
- US Geological Survey Priority Ecosystem Science Program
- Delta Stewardship Council


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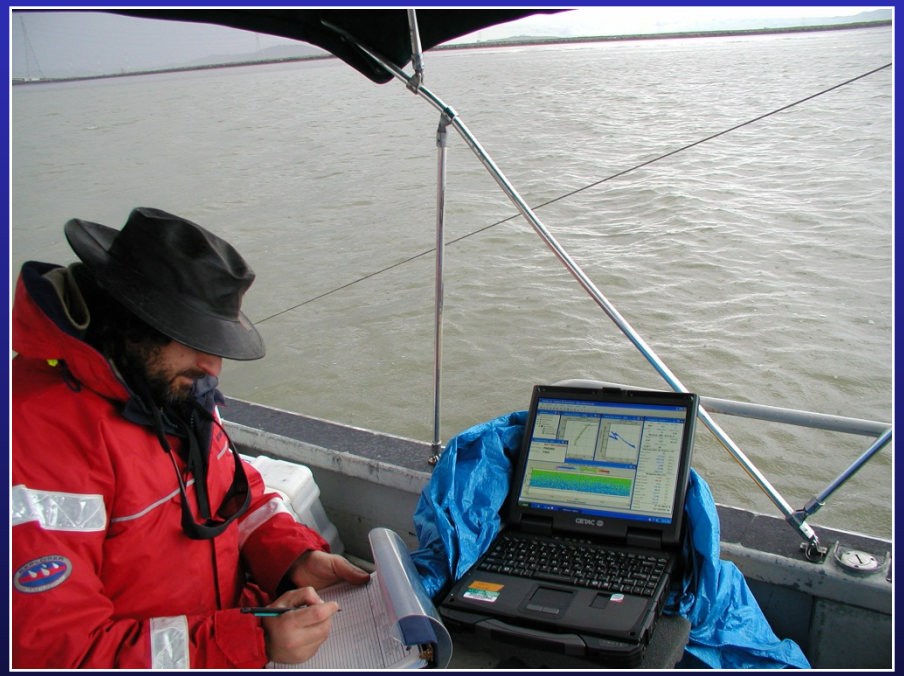
# San Francisco Estuary and Watershed Sediment Transport Group Current Staff



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